ENERGY SAVINGS OPPORTUNITY SURVEY
FORT BELVOIR, ALEXANDRIA, VIRGINIA

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FINAL SUBMITTAL
VOLUME I

Executive Summary

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VOLUME I

EXECUTIVE SUMMARY

1.0 INTRODUCTION

Fort Belvoir is a permanent United States Army installation located about fifteen miles south of Washington, D.C., in Fairfax County, Virginia. The facility consists of offices, research and training facilities, family housing and barracks.

The Energy Savings Opportunity Survey (ESOS) for Fort Belvoir is a project to improve energy efficiency of the buildings by analyzing selected energy conservation opportunities (ECOs) indicated in the scope of work and making recommendations for other ECOs which may be applicable.

This project is funded under the National Energy Conservation Policy Act (NECPA). ESOS projects have the prime objective of evaluating energy conservation opportunities (ECOs) in quest of meeting the goals of the NECPA, the Army Energy Plan and the Department of Defense Energy Management Plan.

This study constitutes the final submittal and includes the project criteria and the methodology used for conducting this analysis and programming documentation for selected projects. The study also includes an ECIP analysis summary for each ECO that was evaluated.

Engineering services for this project are being provided by Engineering Applications Consultants, P.C. under Contract No. DACA 31-89-C-0198 for the Department of the Army, Baltimore District Corps of Engineers.

Significant assistance and cooperation has been provided by the Corps of Engineers and the user agency for this analysis. EAC wishes to extend special appreciation to Mr. James Hawk for his cooperation and guidance, which has contributed to the development of this study.

2.0 PROJECT SUMMARY AND RECOMMENDATIONS

This study contains the findings of the Energy Savings Opportunity Survey at Fort Belvior, Virginia, and is based on the field survey, discussions with the users and the operating personnel and the review of drawings whenever available. Volumes I and II of this study contain the project criteria, methodology, building narrative and programming documentation. Volumes III and IV contain calculations and back-up data.

The project criteria lists environmental conditions within the buildings and climatic data applicable to the project site. Included under project criteria are fuel rates, incentives offered by Virginia Power for implementing energy conservation opportunities, economic life of the improvements and discount factors.

The methodology section of this study contains a description of energy saving opportunities considered under this survey and the procedures for calculating the energy savings. The recommended ECO's have been prioritized by taking synergism into account.

Ten buildings in the Belvoir Research Development and Engineering Center (building series 300) were analyzed for summer steam usage. These buildings use steam during summer for the re-heat type air conditioning system and for the domestic hot water system. Of the four alternatives considered, individual low pressure steam boilers located in each builiding for summer use had the highest SIR of 11.6 and the quickest payback of 2.1 years at a cost of approximately $575,000, exclusive of design cost. This ECO is recommended for implementation based on the ECIP analysis and is estimated to save 30,459 Mbtu and $192,150 annually.

The Control Tower (Building 1359) at Davison Air Field is over forty years old. The building has a poor envelope and its heating and cooling system provides poor environmental conditions for the occupants. The operation of the building's heating and cooling system was modeled using a computer program. A number of ECOs were analyzed by taking into consideration the

interaction of the ECOs. The following ECOs are recommended for implementation with synergistic effects accounted for.

ECO	COST	SIR	PAYBACK
Radiator Control Valves	$ 945	3.3	3.7 Yr.
Ceiling Insulation	$ 530	3.2	4.7 Yr.
Weather Stripping	$ 723	1.7	2.5 Yr.
Night Setback	$1,188	1.4	7.5 Yr.
Reflectors	$ 768	1.3	6.2 Yr.

The implementation of these ECOs at a total cost of $4,154 will result in savings of $700 per year.

Insulating of the exterior walls was also evaluated for Building 1359, although economically not feasible, it is recommended for implementation with the objective of improving the comfort of the occupants. The installation of the insulation will improve the performance of the heating and cooling system by providing a sealed envelope as well as increasing the useful life of the building.

The installation of a diesel or gas generator at Substation 505A was analyzed for peak shaving of electric demand and participation in standby generation program with Virginia Power. None

of the options meets the ECIP non-energy qualification test, or the payback criteria of other non-ECIP programs.

General Officers' Quarters, Dogue Creek Housing, and Rossell Village currently have oil heat. General Officers' Quarters and Rossell Village also have oil-fired domestic hot water heaters, while Dogue Creek, has electric water heaters. Woodlawn Village currently has electric heat pumps and electric water heaters. All of the above housing units have been evaluated for conversion to gas.

Northern Virginia Gas has agreed in priciple to install exterior gas distribution piping at no cost to the Government. The Government and the gas company should conclude negotiations for the extension of the gas lines. The analysis includes cost of curb to housing unit gas lines to the Government. Conversion to gas is economically feasible for Dogue Creek Housing and is recommended for implementation based on ECIP analysis.

Housing Area	Cost W\SIOH	Energy Saved Total (MBTU)	SIR	Payback
Dogue Creek	$205,446	-23	3.84	2.9

For Dogue Creek it has been assumed that the conversion can be implemented in conjuction with Project No. 24566, the design of which is underway by the Norfolk District Corps of Engineers. This conveersion will result in savings of $73,160 per year. The fuel conversion in other housing areas is not feasible for they were evaluated as "stand alone" projects.

As a part of this project, a number of buildings were surveyed for other potential ECO's. These ECO's are not included in the Scope of Work for this survey for evaluation. However, the following ECOs are recommended for further consideration for the 300 area buildings. These ECOs are likely to result in a substantial energy savings to the post.

- Install missing pipe and equipment insulation in the buildings identified in the narrative.
- Evaluate the air distribution system for reducing outside air and supply air.
- Evaluate the installation of night setback and heating water temperature reset.
- Lower the temperature of domestic hot water.
- Evaluate the reset of multi-zone unit hot deck temperature.
- Evaluate lighting in selected buildings for energy related retrofit.

3.0 BUILDINGS' DESCRIPTION

The scope of work of this Energy Savings Opportunity Survey includes the following buildings:

307, 309, 317, 327, 331, 334,
357, 362, 363, 365, 505A, 1359

All buildings in the 300 series are of brick masonry construction. They range in area from approximately 16,500 square feet each in buildings 317 and 334 to about 64,100 square feet in building 331. The buildings' usage includes, but is not limited to, combinations of office areas, laboratories and workshops. Building 505A is an electrical substation serving 0-99, 200, 400 and 500 areas. Building 1359 is the Aircraft Control Tower at the Davison Army Airfield and is a seven level steel structure with metal panel walls. It has a gross area of 2,870 square feet. All the buildings, except 505A, are heated and cooled. Cooling requirements are met by packaged chillers in each building. Some buildings have DX systems and roof-top packaged units. Heating and service hot water requirements of buildings are generally met by reducing the high pressure steam from the building 332 central plant. Lighting is mostly fluorescent.

In addition, the following housing areas are also included for study of fuel conversion:

General Officers' Quarters (59 units)	Buildings 1-19, 21-60
Rossell Village (30 buildings, 60 units)	Buildings 401-419, 421, 423-432
Dogue Creek (45 buildings, 270 units)	Buildings 900-944
Woodlawn Village (143 buildings, 444 units)	Buildings 2600-2608, 2610-2656, 2660-2688, 2700-2708, 2710-2720, 2730-2740, 2750-2761, 2770-2776, 2780-2787)

The General Officers' quarters have oil-fired steam boilers and hot water heaters, whereas Rossell Village units have oil-fired hot water boilers and hot water heaters. The Dogue Creek housing units have oil-fired warm air furnaces and Woodlawn Village area has electric heat pumps. Both areas have electric water heaters.

4.0 ENERGY CONSUMPTION

4.1 Annual Energy Used

An analysis for an energy conservation project requires determination of existing energy-usage pattern. However, in the absence of any individual metering and due to a limited scope of the project, the following baseline energy consumption has been established **only for the affected systems** in the respective buildings.

PRESENT ENERGY USAGE

Buildings	MBTU/Yr
300 Area	97,222
900-944 (Dogue Creek)	16,340
1359 (Control Tower)	470
TOTAL	114,032

4.2 Source Energy Used

The following table summarizes the baseline energy consumption:

FUEL	SITE ENERGY MBTU/YR	SOURCE ENERGY MBTU/YR	COST $/YR
Electricity	5,364	5,364*	96,938+
Residual Fuel Oil	96,063	128,724**	894,475
Distillate Oil	12,605	12,605	93,655
Total	114,032	146,693	1,085,068

* Based on ECIP guidance of 25 April 1988 (Purchased Electric Power)

** Based on site energy conversion of 1,000 btu/lb. (TM 5-838-2) and source energy conversion of 1,340 btu/lb. (ECIP guidance)

+ Includes demand charges

5.0 ENERGY CONSERVATION ANALYSIS

5.1 Energy Conservation Opportunities (ECOs) Investigated

The energy conservation opportunities for each building are identified in the Scope of Work for this project. These opportunities are discussed below.

Summer Steam Evaluation

The objective of this evaluation is to investigate the economic feasibility of providing the buildings listed with an alternate source of steam during the non-heating months. These buildings are 307, 309, 317, 327, 331, 334, 357, 362, 363, and 365 in the Belvoir Research, Development and Engineering Center. Four alternatives have been considered, as follows:

1. Install a new boiler at the central heating plant #332 to handle only the summer load allowing the large boiler to be shut down.

2. Install a new boiler at each building for summer load allowing central heating plant #332 to be shut down.

3. Install a new steam and condensate main, sized for summer load, from the central heating plant #1422 to the 300 area distribution system allowing the central plant #332 to be shut down.

4. Install a new steam and condensate main, sized for year-round load, from the central heating plant #1422 to the 300 area allowing the central plant #332 to be permanently closed.

Peak-Shaving Generators

The purpose of this analysis is to evaluate the feasibility of using a diesel generator to shave off electric demand and thus reduce demand charges year round. The diesel generator will be installed at the site of the existing Substation 505 A. Two options were conceptualized for analysis for using the generator.

Option A: Peak Shaving - Use generator during on-peak hours to reduce electrical demand.

Option B: Standby Generators - Participate in Virginia Power Standby Generator Program, under rate schedule MSSG.

Computer Model

The Aircraft Control Tower at the Davison Army Airfield, Building 1359, was targeted for computer modelling for its enegy usage and energy savings from the energy conservation opportunities (ECOs) to be identified. The following ECOs were identified and investigated.

1. Wall Insulation

It is proposed to add 2" wall insulation (R-11) by installing an exterior wall insulation system to improve the U-value for the wall assembly from 0.4 to 0.074 Btu/hr-SF-°F.

2. Roof/Ceiling Insulation

Six inches of batt insulation will be installed above the suspended ceiling to provide additional R-19 insulation. The U-value will improve from 0.22 to 0.0425 Btu/hr-SF-°F.

3. Replace Single Glazed Windows with Double Glazed Windows

Most of the existing windows in this building are single-glazed. These windows will be replaced with double-glazed windows, which will improve the fenestration characteristics, namely U-value from 1.0 to 0.58 and glass factor from 1.0 to 0.9.

4. Weatherstripping

It is assumed that weatherstripping will plug the cracks and gaps and reduce infiltration into the building.

5. Night Setback

The building does not have any night setback controls. Under this ECO, time clock controls will be provided for the HVAC systems to save energy during the unoccupied period.

6. Radiator/Unit Heat Control Valves

Free flow of steam in the radiator and unit heater causes overheating. Control valves are proposed to cut-off steam when a preset temperature (68°F.) is reached.

7. Reflectors

The fluorescent light fixtures on the third floor are open type fixtures. It is proposed to install reflectors to generate savings in lighting and cooling costs. However, heating costs will increase by a small margin.

8. Occupancy Sensor

Lights in the conference room on the sixth floor stay on for a large period of time. An occupancy sensor will turn the lights off when not required. Installation of reflectors will result in energy savings in lighting and cooling but will result in marginal increases in heating energy.

Fuel Conversion

The investigation focussed on conversion of existing fuel, oil or electricity, to natual gas for heating and service hot water needs in the 833 residential units in the following housing areas.

	Existing	Proposed
General Officers'Quarters (59 units)	Oil-fired boilers & water heaters	Gas-fired boilers and water heaters
Rossell Village (60 units)	Oil-fired boilers and water heaters	Gas-fired boilers and water heaters
Dogue Creek (270 units)	Oil-fired furnaces & electric water heaters	Gas-fired furnaces and water heaters
Woodlawn Village (444 units)	Heat pumps and electric water heaters	Gas-fired furnaces and water heaters.

The conversion to gas-fired equipment involves extending new gas lines to these areas.

5.2 Recommended ECOs

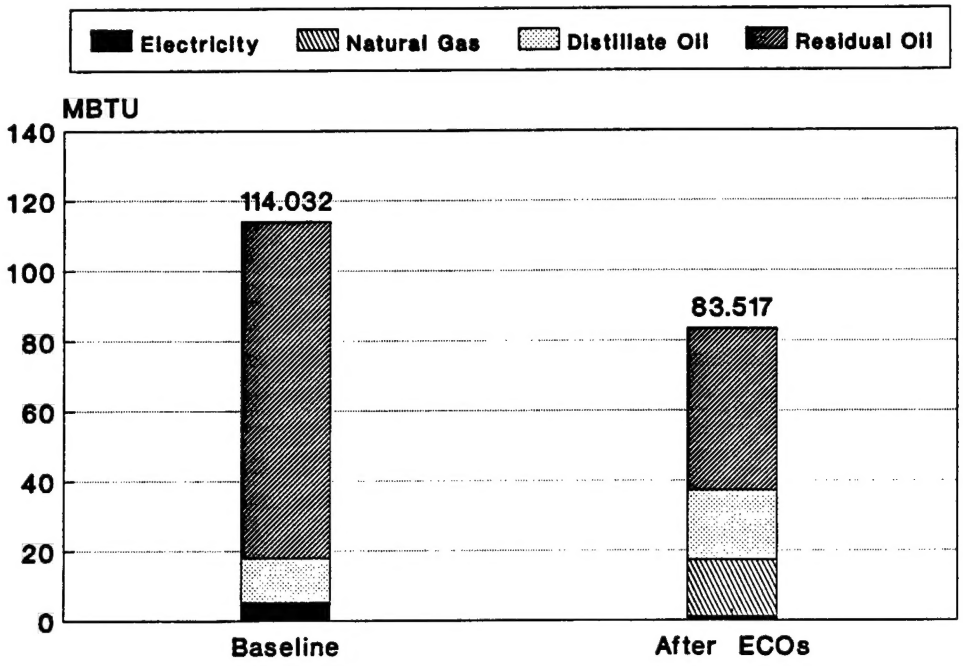
The feasibility of each ECO was determined on the basis of energy savings calculations (taking into account synergistic effects), investment cost estimates, and life cycle cost analysis. Savings to investment ratio (SIR) of unity, or greater, for an ECO qualifies it for implementation.

6.0 ENERGY AND COST SAVINGS

The following table presents the estimated energy usage patterns and costs before and after the implementation of the recommended ECOs.

	Existing Energy & Cost	Energy and Cost After Implementation of ECOs	Savings After Implementation	
			%	Savings
Site Energy Consumption				
Electricity Mbtu	5,364	1,097	79.5	4,267
Natural Gas Mbtu	---	16,308		(16,308)
Distillate Fuel Oil Mbtu	12,605	19,702	(56)	(7,097)
Residual Fuel Oil, Mbtu	96,063	46,410	51.7	49,653
Total Mbtu	114,032	83,517	26.7	30,515
Source Energy Consumption				
Total Mbtu	146,693	99,296	30.2	47,397
Energy Costs				
Per/year	$1,085,068	$652,662	39.4	$432,906

Energy Usage by Fuel



7.0 ENERGY PLAN

The following categories of programs are available for the recommended ECOs:

Energy Conservation Investment Program (ECIP); This program is for projects which have a construction cost estimate greater than $200,000, a savings to investment ratio (SIR) greater than one and a simple payback period of eight years or less.

Productivity Capital Investment Programs (PCIP): The projects that do not qualify for ECIP fall into the category of Productivity Capital Investment Programs (PCIP). The following categories of PCIP programs are available for the recommended ECOs:

1. Quick Return in Investment Program (QRIP): This program is for projects which have a total cost of less than $100,000 and a simple payback period of two years or less. Three year procurement (AMMO and OPA) appropriations are available for this program.

2. Productivity Enhancing Capital Investment Program (PECIP). This program is for projects which have a cost greater that $100,000 and a simple payback period of four years or less. Projects under this program must be pre-identified two fiscal years in advance.

3. OSD Productivity Investment Funding (OSD PIF). This program is for projects which have a cost greater that $100,000 and simple payback period of four years or less. The projects under this program require MCA funding. Because of the difficulty in obtaining MCA funding, implementation under this program has not been considered.

Considering the availability of the above programs, the following packages have been prepared.

ECIP - Installation of oil-fired boilers and water heaters in the 300 area will qualify under this program as under:

ECO Description	Cost (Incl. SIOH) FY 1991	Program Year 1993
Install oil-fired boilers in buildings 307, 309, 317, 327, 331, 357, 362, and 363 and water heaters in buildings 334 and 365	$575,562	$600,291

The annual savings will be 30,459 Mbtu and a cost savings of $192,500.

PECIP - Replacement of oil-fired furnaces and electric water heaters with gas-fired furnaces and water heaters in the 900 area (Dogue Creek) will qualify under this program.

ECO Description	Cost (Incl. SIOH) FY 1991	Program Year 1993
Replace oil-fired furnaces and electric water heaters with gas-fired furnaces and domestic water heaters in 270 housing units in the 900 area (Dogue Creek).	$205,446	$214,280

The annual energy savings will be negative, but due to the change in fuel, the cost savings will be $73,150 per year.

Low Cost Projects - The energy conservation opportunities (ECOs) determined feasible for Building 1359 (Control Tower) maybe implemented at low cost.

ECO Description	Cost (incl. SIOH)
Install radiator control valves, ceiling insulation, weatherstripping, night set-back controls, and fixture reflectors in Building 1359.	$4,154

The energy savings will be 79 Mbtu and $700 annually.